

TITLE: REAR VIEW MONITORING SYSTEM FOR MOTOR VEHICLES

BACKGROUND OF THE INVENTION

1. Field of the Invention

5 This invention relates to devices used to visually monitor the areas alongside and behind a motor vehicle while the vehicle is in operation.

2. Description of the Prior Art

10 It is necessary for a person operating a motor vehicle to be aware of other vehicles or other objects beside or behind his vehicle. Currently this is done through the use of rear view mirrors. Usually there is a rear view mirror inside the vehicle, centered high on the windshield to visualize the road behind the vehicle through the rear window. In addition, there is usually a 15 mirror outside the door window on each side, to visualize the area beside and behind the vehicle.

Said rear view mirrors have several shortcomings. Firstly they each have a narrow field of vision so that they leave blind spots, particularly to the left rear and to the right rear of the 20 vehicle. Such blindspots make it necessary for the driver to turn his head rearwards before he can change lanes or make appropriate maneuvers, thus diverting his attention from the area ahead of the vehicle. Features such as the roof-supporting pillars of the vehicle, head rests, and even passengers obstruct the view, so that 25 even when the driver turns his head backwards, he still may not have a complete view of areas in the blind spots. Such obstructions are worse in delivery vans, trucks and buses.

The problems with the blind spots are especially severe with big trucks with "cab over engine" design where the outside rear view mirrors are necessarily placed at a high position, causing the driver to be unable to see low-silhouette vehicles alongside his  
5 vehicle. A system that will provide a rear view from a lower vantage point would go far towards solving this problem.

Yet another problem with outside rear view mirrors is that deposits of ice, snow or condensed moisture on the window adjacent to the mirror will obscure the driver's view of the mirror.  
10 Sometimes the exterior mirrors themselves become covered with occluding deposits such as condensed moisture, snow rain or dirt, thereby diminishing their effectiveness.

Because current outside rear view mirrors protrude outwardly from the otherwise smooth contour of the external surface of the  
15 vehicle, they detract from the vehicle's appearance and streamlined efficiency. It is not possible to reduce the size of this protuberance as long as its function relies on the use of mirrors which must necessarily be of adequate size.

There is also no way to adjust the brightness or contrast of  
20 the image seen in conventional rear view mirrors. What it reflects is what the driver sees, whether it is too dark or too glaring.

Currently some vehicles, especially towing trucks, are equipped with special video monitoring devices to visualize the towing hitch to assist the operator in maneuvering the vehicle for  
25 hitching it to the trailer. These video monitors are not, however, satisfactory for supplanting or complementing the rear view mirrors and do not solve the problems enumerated above. For one thing, a

video camera facing backwards gives a regular direct view of the observed area, whereas a standard rear view mirror provides a "mirror image" of the observed area.

This difference is crucially important from the functional  
5 point of view because objects seen on one side of the mirror (when viewed through a standard rear view mirror) will appear on the opposite side of the viewing screen when seen through a rearward facing video monitor lens. The average driver, trained to react quickly to the mirror images presented by the standard rear view  
10 mirrors, will then tend to react with the wrong maneuver upon seeing these "turned around" direct images on the video screen. A better approach would be a system which would show a "mirror image" on the video screen just like the ones shown by the standard rear view mirrors. A driver could then use this system just as easily  
15 as he uses standard rear view mirrors. Furthermore, he would enjoy other advantages as discussed below.

In motor vehicles, whether automobiles or trucks, the driver's seat is positioned adjacent either the left or right side door and associated window. For example, in the United States the driver is  
20 adjacent the left door, and in England and other countries, the driver sits adjacent the right door. Accordingly, the driver is never seated equidistantly between the rear view side mirrors located outside the vehicle and adjacent the windows of the doors. As a consequence of the uneven spacing between the driver's head  
25 and the left or right side mirror, the driver's viewing angle is greater with respect to the closest mirror than the more distant mirror.

In order to cause the more distant mirror to provide the same effective field of view as the closer mirror, the more distant mirror is caused to have an outwardly convex curvature, which widens its viewing angle. However, the widened viewing angle  
5— causes objects seen in the mirror to appear smaller than they should be. This creates the psychological impression that such objects are further away than they really are, particularly in comparison with the image in the closer mirror, and such distorted impression can produce driving accidents. In fact, all such convex  
10 mirrors bear the message "Objects in mirror are closer than they appear."

In a related issue concerning the location of the driver's eyes relative to the rear view mirrors, it is to be noted that, when drivers of different heights drive the same vehicle on  
15 different occasions, the angular position of all three mirrors must be adjusted. Although this is merely an inconvenience prior to travel in the vehicle, there could be serious consequences if such mirror re-adjustment is forgotten.

U.S. Patent 4,277,804 to Robison discloses the use of a mirror  
20 in association with a television camera to provide a mirror image view of the area behind a trailer truck. The mirror image is viewable on a screen adjacent the driver of the truck. Robinson's system cannot be readily adapted to monitor areas at the sides of the truck.

25 U.S. Patent 6,424,273 to Gutta et. al. discloses a vision system for an automobile employing paired television cameras protruding from opposite sides of the automobile forwardly of the

driver, and a rearwardly directed third camera. The images provided by the cameras are displayed as a composite image in a single image display device located in front of the driver. This system would tend to be confusing to the average driver who would,  
5 by force of habit, automatically look to the direction of the left and right outside rear view mirrors to check the traffic situation in the left and right adjacent lanes.

It is accordingly an object of the present invention to provide a rear view monitoring system for use in motor vehicles for  
10 achieving improved observation of areas alongside and behind the vehicle, including areas generally referred to as "blind spots."

A further object of this invention is to provide a monitoring system as in the foregoing object which provides a display of equal sized mirror images of observed areas on both sides of the vehicle.  
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An additional object of this invention is to provide a monitoring system that will, firstly, provide an image of the areas to the right and rear of the vehicle on a viewing screen located at or near the place where the conventional right rear view mirror is usually located; secondly, that will provide an image of the areas  
20 behind and to the left of the vehicle on a viewing screen located at or near the place where the conventional left rear view mirror is usually located; and, thirdly, that will provide an image of the areas directly behind the vehicle on a viewing screen located behind the upper middle portion of the windshield where the  
25 conventional inside rear view mirror is usually located, so that the ordinary driver will not need to change his regular viewing habits when checking for traffic in these corresponding areas.

It is another object of the present invention to provide a monitoring system of the aforesaid nature that is unaffected by occluding deposits on the vehicle's windows.

A still further object of this invention is to provide a 5 monitoring system of the aforesaid nature which produces images that can be adjusted with respect to contrast and brightness.

Still another object of the present invention is to provide a rear view monitoring system whose components are substantially non-protrusive from the external surface of the vehicle, thereby 10 enhancing the vehicle's appearance and streamlined contour.

These objects and other objects and advantages of the invention will be apparent from the following description.

#### SUMMARY OF THE INVENTION

15 The above and other beneficial objects and advantages are accomplished in accordance with the present invention by a rear view monitoring system for a motor vehicle having a longitudinal center axis and passenger compartment symmetrically centered upon said axis and bounded in part by front and rear, left side and 20 right side portions of the vehicle, a front windshield, a roof, and upwardly directed roof-supporting pillars, said monitoring system comprising:

- a) first and second rear view side video assemblies installable on opposite sides of the front portion of said vehicle and positioned and configured to produce mirror images of rearward 25 areas contiguous to the left and right sides of the vehicle, respectively,

- b) a third video assembly installable at the rear of said vehicle and configured to produce a mirror image of an area behind said vehicle, and
- c) monitor screens located within said compartment and separately interactive with each video assembly to provide visually observable pictures corresponding to said mirror images, the screens associated with said first and second video assemblies being positioned adjacent pillars on the same side of the compartment as the associated video assembly, and the screen associated with said third video assembly being centered high upon said front windshield.

Said first and second side video assemblies may be installed as far forward in the vehicle as practicable in order to achieve widened effective field of view. In the case of large trucks, said side video assemblies are preferably located in a relatively low position in order to ensure visualization of low silhouette vehicles alongside said truck.

The monitor screens are positioned in the approximate locations the driver would glance toward by habit when checking for conventional mirror-provided images of traffic at the sides or rear of the vehicle. Said monitor screens may be equipped with brightness and contrast controls located at places convenient to the driver.

25 BRIEF DESCRIPTION OF THE DRAWING

For a fuller understanding of the nature and objects of the invention, reference should be had to the following detailed

description taken in connection with the accompanying drawing forming a part of this specification and in which similar numerals of reference indicate corresponding parts in all the figures of the drawing:

5       Figure 1 is a top view of a vehicle equipped with the rear view monitoring system of the present invention, and includes a diagrammatic representation of viewing areas relative to the vehicle.

10      Figure 2 is a magnified top view, partly in section, of the area enclosed by broken lines marked "Fig. 2" of Figure 1, showing schematic details of a video assembly employed in the present invention.

15      Figure 3 is a side view taken in the direction of the arrows upon line 3-3 of Figure 1.

Figure 4 is an enlarged fragmentary sectional view taken in the direction of the arrows upon line 4-4 of Figure 1.

Figure 5 is a side view of a large truck equipped with the rear view monitoring system of the present invention, and further showing the associated viewing areas.

20      Figure 6 is a top view of a vehicle equipped with a rear view mirror system of the prior art, and further shows associated viewing areas.

25      Figure 7 is a side view of a truck equipped with a rear view mirror system of the prior art, and further shows the consequent viewing area.

Figure 8 is a magnified top view, partly in section, of an area similar to that shown in Figure 2, showing details of a first

alternative embodiment of the video assembly employed in the present invention.

Figure 9 is a magnified top view, partly in section, of an area similar to that shown in Figure 2, showing details of a second 5 alternative embodiment of the video assembly employed in the present invention.

#### DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to Figures 1-4, there is shown a passenger 10 vehicle 1 having front portion 2 terminating in bumper 33, rear portion 3, left side portion 4 and right side portion 5. Said vehicle, having a center axis of elongation 107, further comprises a passenger compartment 30 bounded in part by said front and rear, left side and right side portions, and roof 26. Upwardly directed 15 pillars 27 support said roof, and are located at four sites about the perimeter of said compartment in a rectangular array. A windshield 28 generally encloses the front of the compartment, extending upwardly from a dashboard 29 to roof 26.

A first, left video assembly 6 is installed within the left 20 front fender 7 of the car, and a second, right video assembly 8 is installed within right front fender 9. The contour of assemblies 6 and 8 are styled to blend harmoniously with fenders 7 and 9, respectively.

Each video assembly is comprised of an optical lens 10 capable 25 of gathering light at a particular viewing angle to produce a focused image, and a camera body 105 which converts said image into an electronic signal amenable to alteration and transmission by

electronic means. Image reversal means are also associated with each video assembly. In a first embodiment of image reversal means, as shown in Figures 2 and 9, a mirror 20 or equivalent prism 62 is disposed directly in front of the lens and thereby reflects a 5 mirror image into the lens. In such embodiment, the mirror or prism is directed toward the rear of the vehicle. In a second embodiment of image reversal means, as shown in Figure 8, instead of employing a mirror or prism, the camera body achieves reversal of the image by electronic means. Because said mirror-dependent 10 first embodiment allows greater adaptability of placement in the vehicle, its use is emphasized in this disclosure.

Left rear view mirror 20 is positioned to reflect an image of rearwardly monitored area 103 at the left of the vehicle into associated video lens 10. Right rear view mirror 21 is similarly 15 positioned to reflect an image of rearwardly monitored area 104 at the right of the vehicle into the lens component of right video assembly 8. Mirrors 20 and 21 are of substantially rectangular shape, and may be flat or convex, but are identical with respect to viewing angle and consequent magnification effect.

20 Video assemblies 6 and 8 may be miniaturized so that mirrors 20 and 21 are each reduced to about an inch or less in diameter, and are placed in close enough proximity to the associated lenses to enable the lens to function at its full viewing potential. Thus, miniaturization allows mirrors 20 and 21 to be designed in a 25 manner that will blend maximally with the external contour of the vehicle and be as inconspicuous as possible. It is intended that no component of the video assembly will protrude more than 2 inches

away from the vehicle. Contoured, scratch-resistant, optically neutral, easily replaceable lens covers 24 and 25 may be provided for improved styling and protective maintenance.

Left video assembly 6 continuously converts the captured image 5 into electronic data. Said data is transmitted through suitable electrical circuitry to left monitor assembly 12 where it is continuously converted back into a visual picture which is displayed on monitor screen 13. Since the image captured by left video lens 10 is actually a mirror image of the area to the left 10 and rear of the vehicle as reflected by left rear view mirror 20, the image produced on monitor screen 13 is also a mirror image.

Right video assembly 8 likewise continuously translates the image captured by its lens into electronic data which is electronically transmitted to right monitor assembly 14. Said data 15 is continuously converted back into a visual display picture on right monitor screen 15. Since the image captured by the right video lens is a mirror image as reflected by right rear view mirror 21, the visual picture displayed on right monitor screen 15 is also a mirror image.

Third video assembly 16 is installed in a location at the rear 20 of the vehicle, preferably directly above center axis 107. It houses a rearward facing central rear view mirror 22 for reflecting an image of monitored area 108 rearwardly of the vehicle into the lens of the video assembly. Said image is processed into an 25 electronic signal which is transmitted to central monitor screen 19 and there converted into a corresponding easily viewed picture. Rear video assembly 16 may be miniaturized to achieve the styling

advantages already described, and may be provided with a lens cover as well. Alternatively, said third video assembly may be housed entirely within the vehicle.

The lenses of the video assemblies are preferably designed to  
5 embrace viewing angles between 35 and 46 degrees so that they can cover large areas of surveillance while still producing images of adequate size. The rear view monitoring system of this invention is amenable to adjustability of viewing angles and/or image magnification. Such adjustability can be met through proper  
10 selection of lenses. For example, a lens of 50 mm. focal length has a viewing angle of 46 degrees, and a lens of 75 mm. focal length has a viewing angle of about 35 degrees. The use of zoom lenses could provide adjustable viewing angles. Adjustment controls may be located on the dashboard within convenient reach of  
15 the driver. It is preferred, however that the three video assemblies provide the same degree of image magnification, and in this connection it should be noted that image magnification is  
20 determined by the <sup>viewing</sup> angle or focal length of the lens. In particular, shorter focal length lenses, with their attendant wide viewing angle produce smaller images.

The monitoring system of this invention can provide a controlled amount of overlap between the view seen at the center screen and the views seen at the side screen. Such overlap provides continuity of imagery as traffic flows from the field of  
25 view of one monitor to that of the other. It is preferred that such overlap be between 5 and 20 percent of the image area at both lateral extremities 116 of central monitor screen 19.

One important aspect of this invention is that the video assemblies 6 and 8 are positioned as far forward on the vehicle as practicable, such as in the illustrated locations far forward on the front fenders. By locating these side imaging units forwardly,  
5 a smaller viewing angle is needed to achieve satisfactory coverage of the "blind spots." Proper forward positioning of the first and second, side imaging video assemblies enables them to cover desired areas 103 and 104 employing a viewing angle that matches the viewing of the third video assembly. Such matching will cause the  
10 pictures on the three screens to be of equal magnification without need for electronic adjustment. Such location of video assemblies 6 and 8 is preferably at a site between 65% and 80% of the distance measured from windshield 28 toward bumper 33.

The effect of the forward placement of the first and second video assemblies is best seen by comparing Figure 1 with Figure 6 which shows a typical rear view mirror arrangement of the prior art. In each case, the viewing angle provided by the mirror or video assembly is shown at 42 degrees as bounded by the side of the vehicle and the broken straight diagonal line 112. A lateral line of sight, shown as broken line 110, is centered upon the head of the driver 111. By comparing the distance 113, shown bracketed, between the side of the vehicle and diagonal line 112 for each case, it is seen that such distance, which is essentially an effective field of view, is at least 50% greater by virtue of the  
20 forward placement of the video assemblies.  
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Monitor screens 13, 15 and 19 are preferably equipped with means for controlling contrast, brightness and possibly size of the

displayed images, with conveniently located control knobs. The left and right monitor screens 13 and 15 are best located on the dashboard near the left and right roof-supporting pillars 27 so that they will be in the approximate area where the driver would 5 ordinarily look as a matter of habit and experience to check the rear view. For the same reason, central monitor screen 19 is best centered high behind windshield 28 where the inside rear view mirror is usually located, as shown in Fig. 4.

The preferred location of mirrors 20 and 21 when used on 10 trucks, having a compartment or "cab" situated in a high position such as above the engine, would be similar to those for cars, i.e. on the front fenders. This has the advantage of visualizing low mounted rear view mirrors, as previously described. This is 15 illustrated by the high viewing area 117 achieved by prior truck side mirror systems, as shown in Figure 7. Such high viewing area fails to embrace vehicle 1 alongside the truck. Suitable locations for the rear video assembly 16 for cars and trucks are shown in Figures 1 and 3, and in Figure 5, respectively.

To illustrate the use of an alternative embodiment of video 20 assembly, there is shown in Figure 8 a video assembly 60 disposed in left front fender 7, equipped with lens 100 directed rearwardly and to the left in order to capture a suitable view of area 103 to the left and rear of the vehicle. The image captured by lens 100 25 is electronically processed into its mirror image and electronically transmitted to left monitor assembly 12 where it is displayed as the mirror image of the observed area. A similar

video assembly is disposed in the right front fender.

Another embodiment of video assembly is shown in Figure 9 where left video assembly 61 is disposed in the left front fender 7 of the vehicle. Reflecting prism 62 is positioned to reflect a 5 mirror image of area 103 to the left and rear of the vehicle. This image is captured by lens 101 of video assembly 61 and is processed into electronic signals that are transmitted to left monitor assembly 12 where it is displayed as a mirror image of the observed area. A similar video assembly is disposed in the right front 10 fender.

When properly installed and adjusted, the rear view video assemblies of this invention serve more effectively than current rear view mirrors and may therefore be used in their place. The rear view monitoring system of this invention provides the driver 15 with substantially complete imagery of significant areas to the side and rear of his vehicle. The provided images are of equal, non-distorted optical characteristics and can be modified with respect to brightness and contrast. The functionality of the system is unaffected by deposits of fog, rain or snow on the 20 vehicle's windows. The interior placement of components of the system enhances the appearance and streamlining of the vehicle. Furthermore, the system does not require adjustment to accommodate drivers of different heights.

Although the preferred embodiment is described in great detail 25 it is to be understood that various changes and modifications may be made therein without departing from the true spirit and scope of the invention which is more fully described in the appended claims.